

CHAPTER 35

INTERSECTIONS

35.1 General

Intersections shall be designed to provide for the safety of motorists, pedestrians, and bicyclists. By their nature, intersections are conflict locations. Vehicles, pedestrians, and bicycles all cross paths. Each crossing is a conflict point. This chapter is based on criteria from the Institute of Transportation, **Engineers Traffic Engineering Handbook**, and current **AASHTO's, A Policy on Geometric Design of Highways and Streets** – current version.

35.2 Intersection Design Criteria

35.2.1 Basic Intersection Design

The basic design of intersections includes the following objectives:

- Minimize points of conflict.
- Simplify areas of conflict.
- Limit conflict frequency.
- Limit conflict severity.

35.2.2 Lane Alignment

All lanes shall be in alignment through each intersection, with a maximum of a 2 ft. shift in a hardship situation only, subject to approval by the Traffic Services Administration (TSA).

35.2.3 Angle of Intersection

Crossing roadways should intersect at 90 degrees whenever possible. In no case shall the new intersection design intersect at less than 80 degrees or more than 100 degrees.

35.2.4 Horizontal Alignment and Vertical Profile

- Horizontal – Intersections may be placed on horizontal curves, provided the tangent lengths, are provided on the minor street.
- Vertical - The street profile grade shall not exceed 4 percent on the approach to the intersection, as measured along the centerline of the street. The profile grade within the intersection streets shall not exceed 3 percent. In areas of hilly terrain and steep grades where it may not be possible to attain a 4% approach to the intersection and a 3% grade

within the intersection, the design may be modified to provide the best design attainable

- Prevailing Street Grade - The grade of the street with the higher classification shall prevail at intersections. The lesser street shall adapt to the grade of the major street. Grading of adjacent property and driveways shall adapt to the street grades.

35.2.5 Exclusive Left Lane Turns

Exclusive left turn lanes shall be provided on Arterial roadways wherever left turns are approved. The Designer shall determine, through the TSA, whether an exclusive left turn lane is warranted at designated locations. The following criteria, based on **National Cooperative Highway Research Program Report 279 (NCHRP 279)**, shall be followed:

- Warrants for Signalized Intersections - A separate left turn lane shall be required if one of the following criteria is met:
 - The left turn design volume is at least 20 percent of total approach volumes, or
 - The left turn design volume exceeds 100 vehicles per hour (vph) in peak periods, or
 - The Level of Service (LOS) criterion, are not satisfied without a separate left turn lane.
- Warrants for Un-signalized Intersections - Left turn lanes may be required at approaches to intersections in which the combination of through, left, and opposing volumes exceeds warrants set up by the District. The TSA will determine which peak hours to consider in this evaluation.
- Speed Warrant - The TSA shall review the proposed or posted speeds and evaluate if the speed warrants turn lanes.
- Accident Warrant - The TSA shall discuss the evaluation of the available traffic data for the previous two years and provide recommendations for turn lanes on major intersections and accesses.
- Design Criteria - Left turn lanes shall be designed to provide the following functions:
 - A means for safe deceleration outside the high-speed thru-lane.
 - A storage length long enough for left turning vehicles so that signal phasing can be optimized and intersection delay minimized.
 - Provides a means of separating movements at un-signalized intersections to reduce left turn impacts on other flows.
- The design elements are the approach taper, bay taper, lengths of lanes, width of lanes, and departure taper.

35.2.6 Exclusive Right Turn Lanes

The Designer shall determine if an exclusive right turn lane is warranted at all Major intersections, whether signalized or un-signalized. The following criteria based on **NCHRP 279** shall be followed:

- Warrants for Right Turn Lanes – warrants for a right turn lane shall be provided at intersections or accesses.
- Design Criteria - Right turn lanes shall be designed to accomplish the following functions:
 - Provide a means of safe deceleration outside the high-speed thru-lane.
 - Provide a separate storage area for right turns to assist in the optimization of traffic signal phasing.
 - Provide a means of separating right turn movements at stop-controlled intersections.
- The design elements are the approach taper, bay taper, lengths of lanes, width of lanes, and departure taper.

35.2.7 Acceleration/Deceleration Lanes

For each high volume driveway and major intersection, acceleration/deceleration lanes shall be considered. The criteria for the requirements are provided below. The specific designs for these lanes shall be in accordance with **NCHRP 279** and this chapter.

35.2.8 Turning Radius

The minimum allowable intersection turning radii are as follows in accordance with the current **AASHTO - A Policy on Geometric Design of Highways and Streets**, later version:

- SU-30 Vehicles - All SU-30 vehicles must be able to turn easily from one street to the next and remain in the correct lane for each roadway. This shall be required for all roadways and alleys.
- B-40 Vehicles - All B-40 vehicles may use more than one traffic lane to complete the turn when turning from the correct lane without crossing into opposing traffic lanes and without tracking onto the curb at corners. This shall apply to all streets.
- WB-50 Vehicles - All WB-50 vehicles may use more than one traffic lane to complete the turn without tracking onto the curb at corners. In addition, the vehicle must make the turn in one forward maneuver. This requirement shall apply to all Arterial/Arterial, Arterial/Collector, Arterial/Connector, Commercial Local/Arterial, Arterial/Local Industrial, Arterial/Local Industrial, Collector/Collector, and Collector intersections at Connectors, Local Commercial, and Industrial streets.

- For all other intersections, the vehicles may use the entire paved surface of the street to negotiate the turn; the vehicle may have to back up to complete the turn.

35.2.9 Curb Returns

- Curb Return Grades - The minimum desirable grade around the curb return should be 1 percent. The minimum allowable grade around curb returns shall be .5 percent.
- Traffic Islands - There are a number of traffic island types:
 - Corner Islands Separating Right Turns - Standard corner islands shall be used in 4- or 6-lane Arterial/Arterial intersections to channelize traffic. Corner islands are not required on 2-lane Arterials. The corner islands shall be designed as raised islands for a right turn lane continuing to an exclusive lane or for a right turn lane stop condition. The striping shall be in accordance with the requirements in the **Guidelines for Pavement Markings and Signage** chapter within this manual.

35.2.10 Median Islands Separating Opposing Traffic

- These islands shall be designed to provide pedestrian refuge.
- The medians must not obstruct the minimum left turn radius for the design vehicle.
- Any landscaped medians shall include drainage facilities to handle sprinkler with trickle irrigation, outfall curb and gutter should be used.
- The medians must be placed such that the required visibility in the intersection is not obstructed.
- Medians must be placed so they do not diminish the intersection use.

35.2.11 Dedicated ROW

Intersections shall be constructed within the dedicated right-of-ways.

- Requirements - All intersection ROWs shall be dedicated to provide adequate ROW for sidewalks, curb ramps, and utilities. Additional ROW may be required for additional left or right turn lane accommodation.
- Roundabouts - On all Arterials and Major Collectors, additional ROW at intersections may be required to accommodate the potential installation of a roundabout in the future.

35.2.12 Intersection Sight Distance

Street intersections shall be designed so that adequate sight distance is provided along all streets. The required sight distance shall be determined by the design speed and grades of the street and the acceleration rate of an average vehicle as prescribed below.

- Minimum Requirements - All designs must provide minimum safe stopping sight distance in accordance with **AASHTO**. Additionally, for all Arterial and Collector intersections, the sight distance must allow a vehicle to enter the street and accelerate to the average running speed without interfering with the traffic flow on the Arterial or Collector street.
- Landscaping and Hardscaping - Additionally, within a 30 ft. by 30 ft. sight triangle at each intersection corner, no landscaping or hardscaping shall be permitted that will block the line of sight, generally higher than 24 in. Major roads may be required to include a 50 ft. by 50 ft. sight triangle.

35.2.13 Channelization

Channelization refers to physical or visual guides to separate vehicles into particular paths.

- Intent of Channelization - Channelization is intended to:
 - Prohibit undesirable or wrong way movements
 - Define desirable vehicular paths
 - Encourage safe vehicle speeds
 - Separate points of conflict wherever possible
 - Cause traffic streams to cross at right angles and merge at flat angles
 - Facilitate high-priority traffic movements
 - Facilitate traffic control scheme
 - Remove decelerating, stopped, or slow vehicles from high-speed through-traffic streams
 - Provide safe crossings for pedestrians/bicycles
 - Provide safe refuge for pedestrians
- Specific Channelization Requirements - Channelization shall be required at locations where it is necessary for safety or to protect the operation of the major street. Examples include:
 - Providing raised medians in all Arterials where left turns are prohibited
 - Exclusive turning lanes, with appropriate striping

35.2.14 Roadway Narrowing

Minor Collector or Local streets may be narrowed at intersections to provide more visibility for pedestrians when approved by the TSA. This shortens the distance necessary for pedestrians to cross the street. The narrowing shall not encroach into bike lanes or travel lanes. Narrowing may not be used on Major Collectors without any parking lanes, on any Arterials, or where the standard width is necessary.

35.2.15 Roundabouts

Roundabouts are considered a form of traffic control when approved by the TSA. Roundabouts shall be considered as two types:

- Modern Roundabouts
 - Mini Roundabouts
- Modern Roundabouts shall be specially designed to the specific need on high traffic volume streets and used to improve traffic flow. The following are certain minimum requirements:
- Central Island Radius - The central island radius shall be determined by the Designer and approved by the District.
 - Roadway Width - The circulatory roadway width shall be a minimum of 30 ft. Concrete truck aprons with a minimum width of 6 ft. shall be provided on the perimeter of the central island.
 - Where Allowed - Roundabouts may be allowed on any roadway as approved by the District designs shall have a documented constructed capacity that meets or exceeds the 20-year projected intersection volume.
 - Purpose - The roundabout is a traffic control device in lieu of a multi-way stop or a traffic signal. Roundabouts assist in improving the performance of intersections that have the following characteristics:
 - High number of accidents
 - High delays
 - More than four legs or usual geometry
 - Frequent U-turns
 - High left-turn movements.
 - Design Software - The roundabout design shall be completed with the aid of computer software.
 - Splitter Islands - Raised splitter islands shall be required on all approaches.
 - Mini Roundabouts - Mini Roundabouts may be allowed in a neighborhood setting for traffic calming:
 - Where Allowed - Mini roundabouts may be used on District Streets and Minor Collectors.
 - Design Basis - The design shall be performed in accordance with the **Guidelines for Pavement Markings and Signage** chapter within this manual.

-- Roadway Width - The circular roadway shall be 20-ft. wide and the approach legs shall be 16-ft. wide.

35.2.16 Concrete Pavement Requirements

The concrete paving shall extend on each approach leg to the beginning points of the bay tapers. Refer to the Standard Drawings for the typical concrete pavement joint locations.

Joints for concrete pavement should include transverse expansion joints, transverse contraction joint, longitudinal contraction joint, and longitudinal construction joints. Span length of slabs or transverse joint spacing shall be equal, with a maximum length of 20 ft.

Transverse joints spacing may be changed at intersections to allow the joint to align with P.T. of curb return. Joints running to the corner shall be radial to the corner curve with 1 ft. minimum length. Transverse expansion joints shall be placed at street intersection P.T's or at 360 ft. maximum spacing.